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ABSTRACT

A study developed a model to assist school administrators to estimate costs associated with the delivery of a metals cluster program at Norfolk State College, Virginia. It sought to construct the model so that costs could be explained as a function of enrollment levels. Data were collected through a literature review, computer searches of the Educational Resources Information Center (ERIC), and consultations with knowledgeable persons in the fields of accounting and administration. Direct and relevant overhead expenses for estimating the per student contact hour costs were identified from basic cost data secured from direct inquiry of qualified sources; records; building plans and specifications; equipment suppliers' catalogs, specifications, and quotations; and the utilization of engineering formulas and constants. Unit costs were computed for present and increasing levels of enrollment, and estimated total program expenditure was adjusted for inflation for a one-year projection. Major findings were that per student contact hour costs for a program and individual instructional areas (1) can be computed using cost accounting concepts and procedures; (2) have instructional salaries as their largest single element; (3) were higher for the machine shop than for the sheet metal, foundry, and welding area; and declined as enrollment increased to optimum size. (YLB)

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NORTHERN ILLINOIS UNIVERSITY

THE DEVELOPMENT OF A MODEL FOR ESTIMATING
THE COSTS ASSOCIATED WITH THE DELIVERY
OF A METALS CLUSTER PROGRAM

A THESIS SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE CERTIFICATE OF ADVANCED STUDY

DEPARTMENT OF INDUSTRY AND TECHNOLOGY

BY

CHARLES R. HUNT

DEKALB, ILLINOIS

AUGUST, 1978

U.S. DEPARTMENT OF HEALTH,
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TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
LIST OF FIGURES	viii
LIST OF APPENDIXES	ix

Chapter

1.	INTRODUCTION	1
	PURPOSE OF THE STUDY	2
	SIGNIFICANCE OF THE STUDY	2
	PROGRAM STATEMENT FOR THE STUDY	4
	Long-Range Goals	4
	Short-Range Goals	5
	Program Objectives	5
	Structure for Delivery of Program	6
	ASSUMPTIONS	7
	LIMITATIONS	9
	DEFINITION OF TERMS	10
2.	SOURCES OF DATA	12
3.	REVIEW OF RELATED LITERATURE	14
	REVIEW PERTAINING TO SPACE UTILIZATION AND REQUIREMENTS	14
	REVIEW PERTAINING TO EQUIPMENT MAINTENANCE GUIDELINES AND REQUIREMENTS	16
	REVIEW PERTAINING TO COST ANALYSIS METHODS	17

Chapter	Page
SUMMARY	26
4. PRESENTATION AND ANALYSIS OF DATA	28
5. SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS	68
SUMMARY	68
SUMMARY OF MAJOR FINDINGS	70
CONCLUSIONS	71
IMPLICATIONS	72
RECOMMENDATIONS	73
BIBLIOGRAPHY	75
APPENDIXES	83

LIST OF TABLES

Table	Page
1. Student Contact Hour Enrollment by Instructional Area and Total Program	29
2. Square Footage Costs of Identified Space Factors	31
3. Cost per Student Contact Hour for Net Assignable Space by Instructional Area	32
4. Metals Cluster Laboratory Equipment, Depreciation, and Repair Allowance	33
5. Cost per Student Contact Hour for Equipment by Instructional Area	38
6. Cost per Student Contact Hour for Equipment Repairs by Instructional Area	39
7. Cost per Student Contact Hour for Insurance by Instructional Area	41
8. Breakdown of Typical Metals Cluster Supplies	42
9. Cost per Student Contact Hour for Supplies by Instructional Area	44
10. Cost per Student Contact Hour for Instruction by Instructional Area	45
11. Cost per Student Contact Hour for Instructional Support by Instructional Area	47
12. Cost per Student Contact Hour for Administration, Secretaries, Office Supplies, Rental of Xerox Machine, Office Machine Repairs, and Printing by Instructional Area	50

Table

Page

13.	Cost per Student Contact Hour for Professional Travel by Instructional Area	52
14.	Cost per Student Contact Hour for Toll Charges Postage, and Direct Telephone Service Charges by Instructional Area	53
15.	Electricity Cost for the Metals Cluster Program	55
16.	Cost per Student Contact Hour for Electricity by Instructional Area	58
17.	Cost per Student Contact Hour for Heat by Instructional Area	59
18.	Distribution of per Student Contact Hour Costs for Objects of Expenditure for the Metals Cluster Program	61
19.	Distribution of per Student Contact Hour Costs for Objects of Expenditure by Instructional Area	62
20.	Comparative Costs for Additional Class Sections in the Metals Cluster Program	67
21.	Student Contact Hours per Year by Emphasis Level for the Metals Cluster Program	95
22.	Net Assignable Space Assigned for Use in the Metals Cluster Program	97

LIST OF FIGURES

Figure	Page
1. Average per Student Contact Hour Cost per Year at Increasing Levels of Enrollment	65

LIST OF APPENDIXES

Appendix	Page
A. EMPHASES DESIGNATIONS AND OBJECTIVES	84
B. STUDENT CONTACT HOURS PER YEAR BY EMPHASIS LEVEL FOR THE METALS CLUSTER PROGRAM	94
C. NET ASSIGNABLE SPACE ASSIGNED FOR USE IN THE METALS CLUSTER PROGRAM	96

Chapter 1

INTRODUCTION

Facility and program planning involve many factors which are not readily evident in the initial planning stages of an educational school plant. Oftentimes, decision-making is obscured by inadequate information for choosing among alternatives.

Consequently, continuous planning must focus on need studies, employment opportunities, space, equipment, students, and studies of unit costs. These elements are essential to management in that they provide tools for administrative decisions concerning when and where resource allocations are required (Tyndall & Barnes, 1962).

There is evidence to show that attention-directing mechanisms are vital since administrative personnel are unable to have firsthand knowledge of all the operations under their control. Similarly, cost data are needed in educational institutions for forming and applying budget standards (Tyndall & Barnes, 1962).

The per student contact hour cost per year, derived for net assignable space depreciation cost, equipment depreciation cost, instructional salaries, instructional support cost, cost of expendable supplies, and other relevant overhead costs, appears to be a vehicle for efficient program planning and implementation.

PURPOSE OF THE STUDY

The purpose of the study was to develop a model which could be used to assist school administrators to estimate the costs associated with the delivery of a metals cluster program at Norfolk State College, Norfolk, Virginia. Further, the study sought to construct the model in such a manner that costs could be explained as a function of enrollment levels.

This research problem differed from other related studies in that it was expanded to include the following input costs: (1) net assignable space depreciation cost; (2) equipment depreciation cost; (3) cost of equipment repairs; (4) insurance cost; (5) estimated cost of supplies; (6) instructional salaries; (7) instructional support cost; (8) divisional administration cost, secretarial cost, cost of office supplies, printing, duplicating, and office machine repairs; (9) professional travel cost; (10) long distance and local telephone charges and postage; (11) estimated utilities cost (electricity, heat).

SIGNIFICANCE OF THE STUDY

The importance of a study of this nature is expressed by several writers in the literature concerning costs as related to facility and program planning in this manner:

A mistake in planning a laboratory could be very costly in terms of money, accidents and public relations. . . . Also, since school or college building or remodeling projects will have only a certain amount of money, extreme care must be used in planning industrial laboratories. A mistake could waste thousands of

dollars--dollars that could be used for other worthwhile expenditures [Campbell, 1974a, pp. 32; 34].

In regard to program budget allocations, Dean (1973) said, "A budget is your educational philosophy expressed in dollars using a formal statement of anticipated expenditures and revenues of the . . . school for a prescribed period of time [p. 24]." Dean continues:

Budget costs for industrial education are usually higher than other basic academic areas and are comparable with fine arts and sciences. Need for special laboratories, materials, and supplies, special equipment and additional facility maintenance tends to swell the budgeted cost per student. However, with proper planning and the use of all available assets, the program can readily adapt to a realistic budget pattern [p. 26].

Margaret B. Carpenter and Sue A. Haggart (1970) reported a number of advantages or outcomes which may result from a cost analysis study. They state:

The goal of the analysis is not to provide the planner with the alternative that maximize or minimize specific characteristics; the goal is to provide information which, together with the judgment of the planner, permits a compromise among the characteristics of the alternatives within the various environmental constraints, such as budget level or political atmosphere [p. 26].

Since the metals cluster program is expected to render significant support services to the Division of Industrial Education and Technology at Norfolk State College, an analysis of program costs was assumed to have considerable merit.

Also, a discussion of the problem with the division chairman disclosed that a study of this nature was needed for internal analysis, and budgeting and accounting purposes.

PROGRAM STATEMENT FOR THE STUDY

An effective educational program is responsible for providing learning experiences which are consistent with human and technological needs. Therefore, this program seeks to provide educational, technical, and operational experiences to help prepare individuals for professional and technically-oriented careers.

The metals cluster program will be designed to serve students coming mainly from disadvantaged backgrounds. However, efforts will be made to make the program flexible to accommodate students with varied or different backgrounds and experiences.

Long-Range Goals

The following long-range goals for the metals cluster program are outgrowths of the educational philosophy of Norfolk State College and the Division of Industrial Education and Technology:

1. To provide a comprehensive program of educational experiences such that students could be able to make rational decisions regarding their education and training for industrial and professional careers.
2. To provide a realistic program such that some of the local and state manpower needs, and the technical and professional needs of students can be met.
3. To provide a comprehensive program of instructional activities such that students will have access to educational

experiences for both vertical and horizontal articulation in an area of the metals field.

Short-Range Goals

The short-range goals for the metals cluster program are directed at achieving the following ends:

1. To redirect the existing metals program to make it more relevant to the needs of students.
2. To seek to obtain the services of an additional faculty member to assist in expanding the program.
3. To add to a pool of knowledge by increasing the level of proficiency of most freshman students through appropriate teaching strategies.
4. To involve industrial representatives in planning and evaluating vocational and/or career aspects of the program.
5. To increase the number and percentage of students completing a cooperative parallel experience in an area of the metals field; for example, welding, machine shop.

Program Objectives

The broad objectives of the metals cluster program will be to provide for increased motivation, interest, and a degree of competence in important areas of the metals field. This will be accomplished through self-paced interaction and cooperative learning experiences.

The three main subobjectives are as follows:

1. to support the drafting and design offerings by providing

classroom instruction in the area of machine shop practices;

2. to enhance the industrial arts offerings by providing well-balanced units of study in sheet metal, foundry, welding, machine shop, heat treatment, and materials testing; and

3. to provide career options to two-year students in welding and machine shop practice, thus making it possible for branching and exiting from the educational structure upon completion of specified modules with some marketable competencies.

Structure for Delivery of Program

The metals cluster program will be delivered on a commonalities basis. There will be three tracks which will entail two-, three-, or four-emphases levels. Baccalaureate level programs will be two of the tracks, while the third will be a two-year terminal program. The features of the emphases levels are listed:

1. Drafting and Design Track (baccalaureate)
 - a. Level I machine shop (basic)
 - b. Level II machine shop (advanced)
2. Industrial Arts Track (baccalaureate)
 - a. Level I (basic general metals)
 - b. Level II (basic machine shop)
 - c. Level III (advanced machine shop)
3. Two-Year Terminal Track
 - a. Level I (basic welding)
 - b. Level II (advanced welding)

- 7
- c. Level III (basic machine shop)
 - d. Level IV (advanced machine shop).

Along with scheduled lecture-discussions, demonstrations, film and slide presentations, and other modes of instruction, the delivery plan will include a block-of-time arrangement in order to keep the common emphases levels together for reaction, interaction, and action learning opportunities. However, in order to remove some of the constraints on this delivery system, students will be provided with selected teacher-prepared modules and commercial learning packages for various class-laboratory activities. Independent and group study will be encouraged to provide latitude for the instructors to manage and facilitate the learning activities of a particular emphasis level in a given track of a class section.

The emphases designations and objectives are shown in Appendix A, pages 85 through 93.

In view of the fact that various types of information would be pertinent to this planning model, the assumption is made that the weekly teaching hours per full-time equivalent (FTE) faculty will be thirty. However, this figure should not be interpreted as the total faculty effort or work load, since advising students, committee assignments, instructional preparation, and other routine responsibilities must be considered in the faculty effort computation.

ASSUMPTIONS

The following assumptions were made in order to more firmly

establish the direction to the study:

1. Divisional enrollment is expected to increase approximately 7 percent per year for the next five years.
2. Each classroom-laboratory will be staffed with two full-time instructors and two part-time assistants (work study) and the student-teacher ratio will not exceed twenty to one; and, further, the maximum enrollment will be forty students per section.
3. Total enrollment in the metals cluster program will be restricted to 160 students to circumvent oversaturation of student stations and teaching loads.
4. There will be an equal proportion of students in morning and afternoon class-load sections.
5. The student mix coming from the three tracks will be controlled.
6. Net assignable space and equipment depreciation, as determined by the writer, will be evaluated by a panel of experts at a subsequent time to determine the results of the planning model.
7. The costs of maintaining the building, including custodial services and building maintenance, is a State responsibility and therefore, not included in the computation of instructional costs.
8. The average number of contact hours for one student per year will be 290.
9. The inflation rate will be approximately 10 percent per year.

LIMITATIONS

This study was limited to an analysis of costs for planning a metals cluster program at Norfolk State College. The study was further limited to the following subfactors:

1. Data for this study were limited to an analysis of per student contact hour costs for an academic school year.
2. Depreciation of unit building and equipment was established by using the Internal Revenue Service publication number 534, "Tax Information on Depreciation."
3. Equipment repair costs were established by applying the annual asset guideline repair percentages from the Internal Revenue Service publication number 534, "Tax Information on Depreciation" to equipment depreciation.
4. Expendable supply costs were determined from product information and limited to supply estimates for intended use in the instructional activities.
5. Professional salaries, excluding the chairman's, were limited to the average salary of an assistant and associate professor in the Division of Industrial Education and Technology.
6. Wages for instructional support were computed on the basis of fifteen hours per week for thirty-six weeks per year.
7. The costs of administration were limited to divisional administrative costs.
8. Professional travel cost was based on estimated

out-of-pocket costs for attendance at a national seminar or convention.

9. Estimates of telephone and postage costs were based on fiscal 1974-75 cost data.

10. The electricity cost was computed on the basis of estimated use of electricity in kilowatt-hours in the metals cluster program.

11. The analysis was limited to daytime operation, since courses taught at night are under the supervision of the Evening College.

DEFINITION OF TERMS

For the purpose of this study, the terms listed are interpreted as having the following meanings:

"Academic year" refers to a thirty-six week school year.

"Assignable area" refers to the sum of all interior floor space available to a student for instructional activities.

"Cost" is defined as dollar resources required to achieve institutional and program objectives during a given time period (Topping, 1974).

"Depreciation" refers to a process of distributing the cost of an asset less salvage value (if any), over the useful life of the asset by the straight-line method.

"Division of Industrial Education and Technology" refers to an organizational unit of the college which affords curricula in

industrial arts, vocational-industrial education, and several technology areas.

"Industrial Education" is a generic term encompassing all education related to modern industry and technology. Thus, industrial arts, vocational industrial, and technical education are included (Committee on Vocational-Technical Terminology, 1971).

"Instructional Load Level" refers to the student mix from the three tracks in the class-load sections throughout the academic year.

"Metals Cluster Program" is a consolidated metals program for teaching principles and skills in sheet metal, foundry, welding, machine shop practice, heat treatment, and materials testing.

"Weekly Student Contact Hours" are the contact hours of one student meeting one class section each week throughout the academic year.

Chapter 2

SOURCES OF DATA

Data for this study were obtained from the following sources:

- (1) books and agency publications dealing with cost accounting and budgeting; (2) professional literature devoted to instructional space planning; (3) dissertation abstracts; (4) periodicals; (5) ERIC (Educational Resources Information Center) Clearinghouse in Career Education; (6) building plans and specifications; (7) equipment suppliers' catalogs, specifications, and quotations; (8) supply product and price information from local supply houses; (9) pertinent depreciation and equipment repair data from the Internal Revenue Service publication number 534, "Tax Information on Depreciation"; (10) records in the Office of the Business Manager, Office of the Division of Industrial Education and Technology, Office of the Comptroller, and the Office of Buildings and Grounds at Norfolk State College, Norfolk, Virginia; (11) consultations with knowledgeable persons in the fields of accounting and administration; (12) information from the local Chesapeake and Potomac Telephone Company of Virginia; (13) engineering formulas and constants.

The procedures used for estimating the per student contact hour costs per year involved a combination of cost accounting concepts and methodology. Upon collecting usable data, the expenditures were

separated into direct and indirect expenditure categories. The expenditures which were readily identified with the cost centers were assigned on a direct basis to these centers or functions. The expenditures which were not readily identified with the cost centers, or expenditures classified as indirect expenditures, were prorated to the individual cost centers or functions by using a "step-down" allocation procedure. The proration variables identified to accomplish this task included net assignable space, student enrollment, and student contact hours.

Unit costs were computed by using the annual student contact hours as the measuring parameter.

The detailed methodology of this study is found in the presentation and analysis of data section (Chapter 4).

Chapter 3

REVIEW OF RELATED LITERATURE

This chapter consists of a review of selected literature relating to the problem. This review is presented under the following headings: (1) review of source materials pertaining to space; (2) review of source materials pertaining to equipment; and (3) review of cost analyses methods.

REVIEW PERTAINING TO SPACE UTILIZATION AND REQUIREMENTS

The review of research relative to space utilization and requirements revealed some relationship to the study. The research has, in a study by Ashcraft (1969), sought to develop space standards for use as guidelines in the planning of physical plant facilities for the comprehensive junior college. The study focused on existing student station area, facility utilization, and building efficiency from eight comprehensive junior colleges sampled from the States of California, Florida, Michigan, and New York. The results of the study provided recommendations for:

1. the minimum sizes of student stations in the classroom or laboratory that appear most desirable,
2. the level of room utilization and student station occupancy that should be strived for in plant planning, and

3. the minimum level of building efficiency that should be attained in the construction of facilities.

Farquhar (1972) investigated the physical facility space needs of Jefferson State Junior College, Birmingham, Alabama. The procedure involved a headcount enrollment which was modified and expressed in weekly contact hours. An inventory of existing facilities was made in order to estimate what space was available. The study further attempted to ascertain how the classrooms and class laboratories were used. An assessment was made between the capacity of existing facilities and long-term requirements to determine additional space needs. Space needs were converted to gross square feet in order to establish cost factors. Farquhar presented these findings and recommendations:

1. library space was considered a great need,
2. a computer science laboratory was viewed as a great need by 1979-80,
3. consideration should be given to providing flexibility to space,
4. consideration should be given to removing the present practices of decentralized scheduling of classes and laboratories,
5. cognizance of the hours in the school week that are not allocated for classroom and laboratory use is important,
6. facility planning is a continuous process and should be maintained and periodically updated to ensure continual review, and
7. adoption of a system of space standards would facilitate

continuous planning.

REVIEW PERTAINING TO EQUIPMENT MAINTENANCE GUIDELINES AND REQUIREMENTS

A review of the literature identified one study pertaining to equipment maintenance guidelines and requirements. Froese (1972) devised guidelines for the maintenance of industrial education equipment. The technique entailed a survey-questionnaire which was administered to ten school districts in Arizona and Southern California which enrolled at least five thousand students and offered a program in industrial education. The results provided the foundation for tentative guidelines which were sent to a panel of experts for review and reaction. After an analysis of the panel's reactions, together with the data gathered from the survey, the final guidelines were developed. The guidelines included: (1) maintenance responsibility, (2) record keeping, (3) maintenance programs, (4) equipment, and (5) service contracts. On the basis of the study, it was found that an emphasis was placed on the need for accurate and up-to-date records and the recommended use of data processing equipment where possible. Also, on the basis of the study, the factors determining depreciation were listed and an analysis of the need for replacement versus the repair of equipment was considered, along with selection and purchase of equipment. The study also showed that service contracts were recommended for consideration wherever possible to provide sufficient teaching time for the instructor.

REVIEW PERTAINING TO COST ANALYSIS METHODS

The review of the literature revealed data of pertinence to this study. Much of the review identified cost analyses methods and studies pertaining to unit costs of instruction.

Luhmann's (1968) study attempted to investigate the practicality of using cost accounting procedures for ascertaining the costs incurred for individual student programs. The conduct of this study required the investigator to classify expenditures by fund; general ledger account; object; function; and by unit for allocating expenses to individual classes. The investigator reported that, although the study postulated certain basic principles underlying an effective program cost accounting system, much work remains to be done to make such an accounting system an efficient and effective tool for program cost accounting.

Parry (1969) investigated the cost differentials among trade, technical, and college parallel curricula offered in North Carolina's system of comprehensive community colleges. The study focused on a cost analysis of educational offerings in six technical institutes and four comprehensive community colleges. Educational costs were determined for the years 1965-66 and 1966-67. Instructional salary, supplies, and materials, administration, student personnel, maintenance of equipment, auxiliary services, equipment amortization, plant maintenance, plant operation, and fixed charges were ascertained

and stated as costs per contact hour of instruction. Cost differentials for each cost component in each institution were found. It was also found that as institutional enrollment increased the cost per student contact hour decreased.

On the basis of data describing the relationship between the enrollment size of vocational-technical schools and expenditures per student, Goishi (1970) found that the single most common factor contributing to expenditures per student was the number of students enrolled. It was further concluded that administrative costs and the kinds and amounts of equipment utilized were major contributors to operating costs.

Braun and Jordan (1973) reported that most authorities tend to agree that capital services should be included in any study of full costs of outputs in higher education. It was also noted that these services (land, physical plant, and equipment) make up the ingredients required to support institutional activities and programs.

Keene and Strenglein (1973), in seeking answers to some of the major categories of expense to academic departments, conducted an exploratory study of fiscal years 1967-68 and 1968-69. Costs were obtained on the basis of full-time equivalent students. The investigators found wide variations among departments. It was determined that engineering and the natural sciences were more costly in terms of instructional materials and supplies.

Tepping (1971) conducted a study to ascertain costs of proposed instructional facilities for colleges and universities. The

investigator sought to construct a model for three building types: general classroom, laboratory science, and fine arts. The investigator analyzed two buildings from each of the three categories and constructed composite data provided by the six buildings of similar function to ascertain their validity. Finally, acquisition costs were estimated by cost per station and cost per square foot; estimates were compared to the actual cost of each building to determine the accuracy of the estimating procedure. The following findings were drawn from the study:

1. unit costs of physical facilities varied depending on the acquisition of space,
2. specialized laboratory space was consistently more expensive per station than nonspecialized classroom space,
3. research laboratories were more expensive than instructional laboratories, and
4. the fine arts building was the most expensive instructional area when measured on either a per square foot or per station basis.

A study by Gage and Manate (1969) was conducted to analyze the costs of selected educational programs in the community colleges of Iowa. The investigators sought to ascertain the relationship between the current-unit-cost per student contact hour for arts and transfer curricula and selected vocational-technical programs. Costs per contact hour for each vocational-technical program were correlated and used to ascertain the relationship between student cost and

the factors of enrollment, instructional cost, operation and maintenance of plant, fixed charges, and auxiliary services. On the basis of the correlation analysis, highly significant relationships were found between student cost per contact hour and all of the related factors except equipment. The highest correlation ($-.72$) was between cost and enrollment. The results of the study led the investigators to conclude that all of the factors considered are important for providing the best curricula for the most feasible number of students.

Forbes (1971) conducted a study to analyze costs of an educational program based on behavioral stated instructional objectives. The procedure involved a consideration of the cost of achieving program objectives, overall effectiveness of a program in achieving its objectives, and program effectiveness with subgroups of students. It was reported that the four essential elements of a cost-effectiveness analysis are: (1) program description, (2) student characteristics, (3) effectiveness measures, and (4) costs. The investigator also emphasized that the application of this technique demonstrates the economic and operational feasibility and the acceptability of effectiveness analysis by local educational agencies.

Jacobs (1971) reported a study designed to determine the instructional costs for each department in the College of Liberal Arts at Arizona State University, Tempe, Arizona. The investigator attempted to answer questions relating to the curriculum and the faculty at each level of instruction in each department in the

college. It was reported that the departments differed quite widely in the variety and the scope of the classes offered. It was also reported that there was considerable shifting among the departments across the three levels of instruction. On the basis of the study, it was found that student-credit-hour production, by itself, was not the most important factor in the instructional costs. A high weighted average class size (WACS) correlated positively with a high salary. In addition, one class in ten in the college had fewer than ten students, while one class in thirty had fewer than five students. It was noted that the costs per student-credit-hour production for classes taught by professors and associates were comparable, while the costs for assistants, instructors, and other faculty members were lower, in that order.

A study by Deputy (1970) was conducted to develop a method of cost analysis for selected vocational and academic courses in nine selected high schools in Iowa. The technique involved choosing randomly from two groups, one having enrollment grades nine through twelve or fifteen hundred or more and the second with enrollment of 400 to 1499, all offering at least four vocational programs eligible for federal reimbursement. Data for the study were obtained from the following sources: (1) annual evaluation guide (statement of secondary program), (2) Iowa professional school employees data sheet, (3) print-out of vocational reimbursement (1968-69), and (4) budgets of the individual schools. Several significant findings were reported in the study, however, the following three are noteworthy:

1. the size of the school did not appear to be a factor in the cost per unit credit per contract day,
2. capital outlay for equipment was not a major factor in the higher costs per unit credit day of the vocational program, and
3. vocational programs had a consistently higher cost per unit contract day than did the academic program.

Sheerer (1972) reported a study which sought to ascertain the semester instructional cost to educate a student in institutional offerings. The basic formula of Equivalent Student Credit Hour = $L + 2U + 3G$ assumed that more faculty time and energy are consumed in upper-level courses over a lower course and in graduate courses over both upper- and lower-division courses. The conduct of this study involved calculating the cost per student credit hour. In making the study, the investigator obtained departmental costs, salary, nonsalary and library book allotment to compute the department's share of the undergraduate dean's office and the graduate dean's office, if the department had a graduate program. On the basis of existing data, the total direct cost was determined; however, there was a need to assign indirect cost to each department since these were viewed as essential for instruction. The results of the study led the investigator to conclude the following:

1. the concept of an equivalent student credit hour and the method of generating cost per equivalent student credit hour provides a valuable tool for academic decision-making; and
2. applied without other considerations, it is too blunt an

instrument to use in evaluating the worth of a program among institutions' offerings.

Swanson (1973) studied the costs of differential staffing. The purpose was to compare the costs of the traditional staffing patterns to differential staffing. The investigator found that:

1. differential staffing had little or no effect over the traditional system;
2. flexible scheduling of students and support services, such as aides and media, will cost more, depending on the quality of these services upon entering; and
3. expenditures of capital outlay to construct facilities appeared to cost little more for innovative programs than would be required for traditional programs.

Gramberg (1971) completed a cost study which indicated that student cost, based on course activities, can be identified and used to figure course and area cost. In this study, the investigator sought to determine the following for the areas of drafting and woodworking: (1) supply cost per course in each area; (2) equipment depreciation cost per course in each area; (3) instructional cost per course in each area; (4) departmental administrative cost per course in each area; (5) secretarial cost per course in each area; and (6) office supply cost per course in each area. The area cost, which was directly identified with the course activities, was converted to course cost by multiplying the per student area cost for each direct object of expenditure (cost) by the number of students per

course in each area. Allocated administrative cost, secretarial cost, and office supply cost per course in each area were computed by dividing each indirect expenditure (cost) by the number of students enrolled in all courses in the department, and then multiplying the derived figure by the number of students per course in each area. The findings of the study included the following:

1. student cost varied according to the course activities;
2. there is a direct relationship between the activities in a course and the number of students per course;
3. the number of contact hours in a course had no significance in computing the total course cost;
4. equipment depreciation cost could be computed when life expectancy was estimated, maintenance records were analyzed, and student use was identified;
5. yearly supply and equipment cost can be estimated for future years when student enrollment is known; and
6. when expenditures are known, a program budget can be developed.

Among the major conclusions were:

1. Specific cost per student for a course can be determined as well as specific costs for major areas.
2. The activities of a course must first be identified in order to determine the other varying factors such as supplies and equipment used.
3. When activities are defined, the supplies and equipment

used can be determined and the cost per student computed.

4. The number of students in a course determines the instructional and secretarial cost.

5. Detailed records must be kept in order to have more specific cost figures in the areas of office supplies and administrative time.

6. Added time and expense are justified in the interest of better budgeting.

7. The inclusion of depreciation cost in computation of a departmental budget is vital because equipment necessary for course activities does become inoperative, unmaintainable and obsolete.

8. The instructor's judgment is a human variable in arriving at the life expectancy of equipment in his laboratory.

9. New program additions for a department can be reviewed with greater detail when the new program is subjected to a budget model.

Tepping, (1972) reported that unit cost analyses consist of relating a group of costs to some unit of measurement. It was further noted that the problem begins with the selection of a numerator, or group of costs under consideration, and the selection of a denominator, or unit of measurement. It was also reported that a relationship must exist between the numerator and the denominator in order to produce a usable cost measure.

SUMMARY

A thorough review of the literature revealed many techniques and methods of cost accounting and budgeting procedures. However, this review showed no similar study pertaining to the optimum or estimated total cost per student for a program at the divisional, or departmental, level. Similarly, no study was found which showed the relationship of per student costs by instructional area, nor the relationship of an optimum or estimated total program cost related to increasing levels of enrollment.

The most frequent implications of studies pertaining to space and equipment have been for space needs, space planning and utilization, and equipment maintenance guidelines and requirements.

A variety of measuring units has been used in computing per student costs in unit cost studies. The most prominent types in the studies reviewed have been credit hours, contact hours, and full-time equivalents. The methods for analyzing and comparing costs have been by selected programs in schools, departments, curricula, and courses.

The findings of the review regarding the cost per student to enrollment size indicate the apparent lack of consistency and agreement of research in the problem area. In a study to investigate cost differentials among trade, technical, and college parallel curricula, Parry (1969), for example, found cost differentials for the various components investigated. The investigator also found that as

institutional enrollment increased the cost per student contact hour decreased. In contrast, Goishi (1970) found that the single most common factor contributing to increasing expenditures per student was the number of students enrolled.

Chapter 4

PRESENTATION AND ANALYSIS OF DATA

This chapter reports data on direct and relevant overhead expenses for estimating the per student contact hour costs for a metals cluster program. Data have been presented and analyzed to illustrate the per student contact hour costs per year for the metals cluster program and by instructional area. These groupings of data were made to provide a model to assist school administrators to estimate the costs associated with the delivery of a metals cluster program at Norfolk State College. It was intended that the model would explain costs as a function of enrollment levels.

It was assumed that the program will require two full-time instructors and two half-time (fifteen hours per week) laboratory assistants to provide optimum educational services to students. With this, 160 students, in two instructional areas, can be taught during an academic nine-month school year. Table 1 shows the number of student contact hours per year by instructional area and for the total program. There were 22,320 student contact hours generated in the machine shop area and 24,192 student contact hours in the sheet metal, foundry, and welding area for a total of 46,512 student contact hours for the total program.

The Industrial Education and Technology Building was occupied

Table 1
Student Contact Hour Enrollment by Instructional Area and
Total Program

Academic school year (36 weeks)									
Degree level	Track served	Content area	Number of sections per year	Number of students per section per year	Yearly instructional load levels		Individual student contact hours (unweighted)	Total weekly student contact hours	Total annual student contact hours ²
					a.m.	p.m.			
Machine shop									
I	Drafting and design	Machine shop	2	10	20	--	4	120	4,320
II	Drafting and design	Machine shop	2	10	--	20	4	120	4,320
III	Industrial arts	Machine shop	2	5	10	--	4	40	1,440
III	Industrial arts	Machine shop	2	5	--	10	4	40	1,440
III	Two-year terminal	Machine shop	2	5	10	--	15	150	5,400
IV	Two-year terminal	Machine shop	2	5	--	10	15	150	5,400
Subtotal					40	40		672	23,160
Sheet Metal, Plumbing, and Welding									
I	Industrial arts	General metals	4	12	24	24	4	192	6,912
I	Two-year terminal	Welding	2	8	16	--	15	240	8,640
II	Two-year terminal	Welding	2	8	--	16	15	240	8,640
Subtotal					40	40		672	24,192
Total					80	80		1,344	47,352

²Figures in this column were obtained by multiplying the total number of weekly student contact hours by the number of weeks in the academic school year.

in September, 1975, and the net assignable metals cluster space cost was derived from the square footage and original cost of that building. Table 2 indicates total building square footage, cost of building, cost per square foot, net assignable space for metals cluster program, net assignable space to each instructional area, and the corresponding cost. By dividing the total cost of the building by the total square footage, a thirty dollar and nine cent cost per square foot was obtained. By multiplying the net assignable metals cluster space by the cost per square foot, the net assignable metals cluster space cost was determined to be 152,436 dollars. By dividing the total cost for net assignable space by forty years of service life, the annual depreciated cost was determined to be 3,810.9 dollars for the metals cluster program.

The cost per student contact hour per year for net assignable space, shown in Table 3, was computed by dividing the total number of student contact hours in each instructional area (taken from Table 1) into the corresponding annual depreciation amount for the area. The cost per student contact hour for the metals cluster program was found to be approximately 8.2 cents. The cost per student contact hour in the machine shop was found to be somewhat higher than for the sheet metal, foundry, and welding area, 9.9 cents and 6.7 cents, respectively.

The useful service life, net salvage value, and a total equipment repair allowance for anticipated equipment repairs were established from data in the Internal Revenue Service publication

Table 2
Square Footage Costs of Identified Space Factors

Space	Square footage	Cost per square foot (\$)	Total cost (\$)	Annual depre- cia- tion ^a (\$)
Gross building space	78,223	30.09	2,353,563	58,839.08
Net assignable to machine shop	2,926	30.09	88,059	2,201.48
Net assignable to sheet metal, foundry, and welding	2,140	30.09	64,377.	1,609.42
Net assignable to metals cluster	5,066	30.09	152,436	3,810.90

^aBased upon a forty-year service life.

Table 3
Cost per Student Contact Hour for Net
Assignable Space by Instructional
Area

Instructional area	Number of student contact hours per year	Deprecia- tion of instruc- tional space (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	2,201.48	0.099
Sheet metal, foundry, and welding	24,192	1,609.42	0.067
Total	46,512	3,810.90	0.082

number 534. Table 4 shows equipment requirements and depreciation, together with a total equipment repair allowance.

Replacement of equipment took into consideration only the estimated service life of the equipment, but did not address the problem of technological obsolescence.

The cost per student contact hour per year for equipment for the metals cluster program was determined by dividing the total number of student contact hours into the total annual depreciated cost.

The cost, when computed, was twenty-eight cents.

Table 5 indicates the cost per student contact hour per year

Table 4

Metals Cluster Laboratory Equipment, Depreciation,
and Repair Allowance

Item description	Quan- tity	Orig- inal cost (\$)	Net salvage value (\$)	Esti- mated service life (years)	Depre- ciation per year (\$)	Equipment repair allowance (%)	(\$)
Machine shop							
Storage rack, bar horizontal	1	300.00	--	40	7.50	--	--
Milling machine, horizontal, 5 hp w/attachments	1	16,585.00	1,500.00	10	1,508.50	5.5	82.96
Lathe, engine, 15" x 50" centers, 7.5 hp w/attachments	2	23,123.60	2,000.00	10	2,112.36	5.5	116.18
Lathe, engine, 13" x 24" centers, 5 hp w/attachments	5	31,412.00	2,635.00	10	2,878.70	5.5	158.33
Milling machine, vertical, 2 hp w/attachments	1	7,668.12	675.00	10	699.31	5.5	38.46
Grinder, surface, 6" x 18", 1 hp w/attachments	1	7,205.00	500.00	12	558.75	5.5	30.73
Grinder, universal-cylindrical, 5 hp w/attachments	1	15,600.00	1,000.00	12	1,373.00	5.5	66.92

Table 4 (continued)

Item description	Quantity	Original cost (\$)	Net salvage value (\$)	Estimated service life (years)	Depreciation per year (\$)	Equipment repair allowance (%)	Equipment repair allowance (\$)
Drill press, 1.5 hp w/attachments	1	1,516.00	100.00	12	118.00	5.5	6.49
Shaper, horizontal, 3 hp w/attachments	1	17,476.00	1,000.00	12	1,373.00	5.5	75.51
Bandsaw machine, vertical, 3 hp w/attachments	1	3,162.00	150.00	12	251.00	5.5	13.80
Bandsaw machine, horizontal, .75 hp w/attachments	1	1,444.50	75.00	12	89.12	5.5	4.90
Grinder, tool and cutter, universal, .50 hp w/attachments	1	4,500.00	150.00	12	362.50	5.5	19.94
Bench center, 8" diameter swing	1	994.00	50.00	12	78.66	5.5	4.33
Grinder, pedestal, 7" wheel, .50 hp w/attachments	1	375.00	25.00	12	29.16	5.5	1.60
Optical comparator, 10" screen w/attachments	1	821.50	50.00	12	64.29	5.5	3.53
Surface plate, black granite, 18" x 24" w/stationary stand	1	300.00	--	40	7.50	--	--
Subtotal		132,182.72			11,511.35		623.68

Table 4 (continued)

Item description	Quantity	Original cost (\$)	Net salvage value (\$)	Estimated service life (years)	Depreciation per year (\$)	Equipment repair allowance ^a (%)	Equipment repair allowance ^a (\$)
Sheet metal, foundry and welding							
Shear, 36" squaring, foot power	1	1,156.00	25.00	20	56.55	5.5	3.11
Heat treatment furnace, 13 kw w/attachments	1	3,683.25	200.00	12	290.27	5.5	15.96
Hardness tester w/attachments	1	1,868.50	125.00	12	145.29	5.5	7.99
Hydraulic testing machine w/1" grips and two sets of flat inserts	1	3,000.00	150.00	12	237.50	5.5	13.06
Foundry furnace, .75 hp w/attachments	1	969.50	50.00	18	51.08	8.0	4.09
Batch muller, 3 hp w/attachments	1	1,891.25	50.00	15	122.75	4.5	5.52
Dry rod oven, bench type, 1,000 watts	1	250.00	15.00	12	19.58	--	--
Bench, gas welding, two station w/single stage line regulators	3	1,045.95	--	30	34.86	2.0	.70

Table 4 (continued)

Item description	Quantity	Original cost (\$)	Net salvage value (\$)	Estimated service life (years)	Depreciation per year (\$)	Equipment repair allowance (%)	Equipment repair allowance (\$)
Welding set-up platen w/stand and holding accessories	1	1,438.50	--	40	35.96	--	--
Spot welder, 20 kva w/attachments	1	1,775.00	80.00	15	113.00	2.5	2.82
Transformer-rectifier AC/DC welding machine, 21.8 kw w/attachments	1	1,626.50	75.00	15	103.43	2.5	2.58
Transformer-rectifier AC/DC welding machine, 15.1 kw w/attachments	2	1,650.00	60.00	15	106.00	2.5	2.66
Mig-rectifier type DC welding machine, 13.0 kw w/attachments	1	1,635.00	75.00	15	104.00	2.5	2.60
Acetylene manifold, 4 cylinder, single row w/1" (B) station valve and flashback arrester	1	550.00	--	20	27.50	--	--
Oxygen manifold, 6 cylinder, single row w/1" (B) station valve	1	305.00	--	20	15.25	--	--
Gas flame cutting machine, radiograph w/attachments	1	793.75	40.00	15	50.25	2.5	1.25

Table 4 (continued)

Item description	Quantity	Original cost (\$)	Net salvage value (\$)	Estimated service life (years)	Depreciation per year (\$)	Equipment repair allowance (%) (\$)
Sub total		23,638.20			1,513.27	62.34
Total		155,820.92			13,024.62	686.02

Source:

U.S. Superintendent of Documents, "Internal Revenue Service Publication No. 534, 1975 ed." Washington: Government Printing Office, 1974. Pp. 33-40, 42-43, 45.

for equipment by instructional area. The cost per student contact hour for equipment for each instructional area was computed by dividing the total number of student contact hours in each area into the corresponding annual depreciation amount for the area. Examination of the data shows that the per student contact hour cost was 51.6 cents in the machine shop area and 6.2 cents in the sheet metal, foundry, and welding area.

Table 5
Cost per Student Contact Hour for
Equipment by Instructional
Area

Instructional area	Number of student contact hours per year	Deprecia- tion of instruc- tional equipment (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	11,511.35	0.516
Sheet metal, foundry, and welding	24,192	1,513.27	0.062
Total	46,512	13,024.62	0.280

As shown in Table 4, page 37, the total annual equipment repair allowance for the metals cluster program was 686.02 dollars. Dividing this figure by the total number of student contact hours,

the cost per student contact hour per year for anticipated equipment repairs was determined to be 1.5 cents.

By dividing the total number of student contact hours in each instructional area into the corresponding annual equipment repair allowance for the area, the cost per student contact hour per year, by instructional area, was determined for anticipated equipment repairs. Table 6 summarizes these data. The analysis of data in Table 6 shows that the per student contact hour cost per year for equipment repairs was 2.8 cents in the machine shop area and .3 cent in the sheet metal, foundry, and welding area.

Table 6
Cost per Student Contact Hour for
Equipment Repairs by
Instructional Area

Instructional area	Number of student contact hours per year	Equip- ment repair allow- ance (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	624.68	0.028
Sheet metal, foundry, and welding	24,192	62.34	0.003
Total	46,512	686.02	0.015

The building insurance cost for the year 1975-1976 was 1,305 dollars. By dividing the total building area (78,223 square feet) into the net assignable metals cluster space (5,066 square feet), 6.5 percent of the total building space was assigned to the metals cluster program. By multiplying this percentage by the cost of the insurance coverage for the building, the net assignable metals cluster space insurance cost was determined to be eighty-four dollars and eighty two cents. Dividing the net assignable metals cluster space insurance cost by the total number of student contact hours resulted in an insurance cost per student contact hour per year of .2 cent.

Of the total space assigned to the metals cluster program (5,066 square feet), 58 percent was assigned to the machine shop area, and 42 percent was assigned to the sheet metal, foundry, and welding area. Since the insurance cost for the total net assignable space was eighty-four dollars and eighty two cents, the prorated insurance cost, by instructional area, was determined to be forty-nine dollars and twenty cents, and thirty-five dollars and sixty-two cents for the machine shop and sheet metal, foundry, and welding area, respectively. By dividing the total number of student contact hours in each instructional area into the corresponding prorated insurance cost for the area, the cost per student contact hour per year, by instructional area was determined to be .2 cent and .1 cent, respectively, as is shown in Table 7.

Table 7
Cost per Student Contact Hour for Insurance
by Instructional Area

Instructional area	Number of student contact hours per year	Insur- ance cost (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	49.20	0.002
Sheet metal, foundry, and welding	24,192	35.62	0.001
Total	46,512	84.82	0.002

Table 8 lists typical assignable supply items which would be consumed in demonstrations and instructional activities. It should be noted that this listing is an approximation (based upon historical data) of supply costs for the total metals cluster program which encompasses a machine shop and a sheet metal, foundry, and welding area. By dividing the total cost of supplies in Table 8 by the total number of student contact hours, the cost per student contact hour per year for supplies was determined to be 7.1 cents.

By dividing the total number of student contact hours in each instructional area into the corresponding supply cost for the area, the cost per student contact hour per year, by instructional area, was determined for consumable supplies. The cost per student contact hour

Table 8
Breakdown of Typical Metals Cluster
Supplies

Item description	Quantity	Unit per year	Total cost (\$)
Machine shop			
Steel, 1018 cold finished rounds	--	801 pounds	278.28
Steel, 1018 cold finished flats	--	1,041 pounds	399.45
Aluminum, 2011-T3 rounds	--	202 pounds	505.00
Aluminum, 2024-T3 squares	--	65 pounds	185.00
Water hardening drill rod	--	--	19.80
Hydraulic oil	1	5-gallon can	26.79
Machine lubricating oil	1	5-gallon can	18.75
Light grease	1	7-pound can	11.61
Soluble oil (coolant)	1	5-gallon can	31.28
Dark thread cutting oil	1	1-gallon can	4.21
Neat white rags	--	100 pounds	64.00
Lead-plate anti-sieze compound	3	1-pound can	7.98
Miscellaneous supplies and expenditures	--	--	300.00
Subtotal			1,852.15
Sheet metal, foundry and welding			
Galvanized steel sheets	--	326 pounds	82.80
Assorted soft iron and pop rivets	--	--	10.00
Solder, 50/50 solid wire	2	2 pounds	8.74
Soldering flux	1	quart	2.32
Petro bond molding sand	--	100 pounds	53.46
Parting compound	--	5 pounds	4.30
Aluminum flux	--	5 pounds	3.20

Table 8 (continued)

Item description	Quantity	Unit per year	Total cost (\$)
Aluminum ingot	--	200 pounds	170.00
Steel, 1018 hot rolled flats	--	544 pounds	125.42
Aluminum, 300 series, .081 gauge, 36" x 96" sheets	2	55 pounds	140.00
Welding electrodes, mild steel	--	550 pounds	234.75
Brazing rod, copper coated steel	--	19 pounds	46.37
Tig wire, aluminum	--	15 pounds	26.50
Mig wire, mild steel	--	90 pounds	52.20
Brazing flux	2	2 pounds	2.50
Standard tip cleaner	1	set	1.95
Renewal flints	2	6 packs	.98
Welding and cutting tips	--	--	30.00
Welding gases	--	--	450.00
Subtotal			1,445.49
Total			3,297.64

per year for supplies is presented in Table 9. Examination of the table shows that the per student contact hour cost per year for supplies was 8.2 cents in the machine shop and six cents in the sheet metal, foundry, and welding area.

Table 9
Cost per Student Contact Hour for Supplies
by Instructional Area

Instructional area	Number of student contact hours per year	Supply cost (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	1,852.15	0.082
Sheet metal, foundry, and welding	24,192	1,445.49	0.060
Total	46,512	3,297.64	0.071

The instructional costs for the metals cluster program were reported from an average salary figure for an assistant professor in the Division of Industrial Education and Technology for the academic year 1975-76. The nine month salary was thirteen thousand dollars; the combined total for two instructors was twenty-six thousand dollars. By dividing this figure by the total number of student contact hours, the cost per student contact hour per year for

instruction was determined to be 55.9 cents.

By dividing the total number of student contact hours in each instructional area into the instructional salary of the instructor, the cost per student contact hour per year for instruction, by instructional area, was determined. Table 10 presents a breakdown of the cost per student contact hour per year for instruction by instructional area. The per-student contact hour cost per year for instruction was 58.2 cents in the machine shop area and 53.7 cents in the sheet metal, foundry, and welding area.

Table 10

Cost per Student Contact Hour for
Instruction by Instructional
Area

Instructional area	Number of student contact hours per year	Instruc- tional cost (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	13,000.00	0.582
Sheet metal, foundry, and welding	24,192	13,000.00	0.537
Total	46,512	26,000.00	0.559

Instructional support costs, or laboratory assistant wages,

were derived from the two dollars and twenty cents per hour wage figure for student assistants in the Division of Industrial Education and Technology for the academic year 1975-76. By involving each part-time laboratory assistant for three hours per day, 180 days per year, the total estimated cost for instructional support was determined to be 2,376 dollars. By multiplying this figure by 20 percent, a program expense, the total direct instructional support cost, or 475.2 dollars, was obtained. Dividing the cost for instructional support by the total number of student contact hours fixed the cost per student contact hour per year for instructional support at one-cent.

Of the total direct instructional support expenditure (475.2 dollars) the wages for each laboratory assistant were fixed at 237.6 dollars. By dividing the total number of student contact hours in each instructional area into the wages of the laboratory assistant, the cost per student contact hour per year for instructional support, by instructional area, was determined. As revealed in Table 11, the per student contact hour cost per year for instructional support was 1.1 cents in machine shop and one cent in the sheet metal, foundry, and welding area.

For the academic year (nine months) 1974-75, 1,920 students enrolled in all courses in the Division of Industrial Education and Technology at Norfolk State College. Multiplying the number of students enrolled in all courses for the base year (1974-75) by 7 percent per year (the annual annual growth rate) resulted in an

Table 11

Cost per Student Contact Hour for
Instructional Support by
Instructional Area

Instructional area	Number of student contact hours per year	Instruc- tional support (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	237.60	0.011
Sheet metal, foundry, and welding	24,192	237.60	0.010
Total	46,512	475.20	0.010

increase of 278, or 2,198 students enrolled in all courses in the division for the projected year. By dividing the enrollment in all courses in the division into an instructional level of 160 students, the prorated enrollment rate was determined to be 7.3 percent.

The twelve-month salary of the division chairman for the year 1975-76, as reported by his office, was twenty-six thousand dollars. The division chairman allocated 75 percent of his time to administrative and 25 percent to instruction, preparation, and other duties; the salary allocation was 19,500 dollars. Multiplying the chairman's

salary by the 7.3 percent prorated enrollment rate, the chairman's administrative cost was determined to be 1,423.5 dollars.

During the academic year 1975-76, three persons with the rank of associate professor served as assistants to the division chairman. The average nine-month salary, as reported by the office of the division chairman, was fifteen thousand dollars. The assistants to the division chairman reported 10 percent, 15 percent, and 20 percent, respectively, for their administrative time. The average percentage of administrative time was determined to be 15 percent. The total salary was forty-five thousand dollars. By multiplying this figure by 15 percent, 6,750 dollars was determined to be the administrative allocation for the assistants to the division chairman. By multiplying the administrative allocation for the assistants to the division chairman by the derived 7.3 percent prorated enrollment rate, the assistants' cost was determined to be 492.75 dollars.

The average twelve-month secretarial costs for two full-time secretaries for the year 1975-76, as reported by the office of the division chairman, was 8,700 dollars (clerk stenographer D) and 6,700 dollars (clerk stenographer B), respectively. The total cost for secretaries was 15,400 dollars. By multiplying the total secretarial cost by the derived 7.3 percent prorated enrollment rate, the secretarial cost was determined to be 1,124.2 dollars.

The total cost of office supplies, rental of xerox machine, office machine repairs, and printing for the academic year 1974-75,

as reported by the office of the Division of Industrial Education and Technology, was 1,491.34 dollars. By multiplying this figure by the derived 7.3 percent prorated enrollment rate, the cost for objects of expenditure in this category was determined to be 108.87 dollars.

The expenditure for divisional administration, secretaries, office supplies, rental of xerox machine, office machine repairs, and printing was determined to be 3,149.32 dollars. By dividing this figure by the total number of student contact hours, the per student contact hour cost per year was found to be 6.8 cents.

In order to ascertain the per student contact hour cost for administration, secretaries, office supplies, rental of xerox machine, office machine repairs and printing, by instructional area, the total number of student contact hours in the metals cluster program was divided into the contact hours in the instructional areas. The derived percentages were then multiplied by the combined prorated cost for the program to determine the cost for each instructional area. Similarly, the total number of student contact hours in each instructional area was divided into the corresponding prorated cost for the area. Table 12 summarizes the per student contact hour cost per year by instructional area. Table 12 shows that the per student contact hour cost for administration, secretaries, office supplies, rental of xerox machine, office machine repairs, and printing was 6.8 cents in each instructional area.

Since the writer was unable to obtain information concerning

Table 12

Cost per Student Contact Hour for Administration,
Secretaries, Office Supplies, Rental of Xerox
Machine, Office Machine Repairs, and
Printing by Instructional Area

Instructional area	Number of student contact hours per year	Administra- tion, sec- retaries, office sup- plies, ren- tal of xerox machine, office machine repairs, and printing (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	1,511.67	0.068
Sheet metal, foundry, and welding	24,197	1,637.65	0.068
Total	46,512	3,149.32	0.068

budgeted professional travel expenditures for faculty members for the 1975-76 academic year, an expenditure figure of 175 dollars for each teacher in the metals cluster program was entered into the model. The total cost was 350 dollars. By dividing the cost of professional travel by the total number of student contact hours, the cost per student contact hour per year was fixed at .7 cent.

In order to ascertain the per student contact hour cost per year for professional travel by instructional area, the total number of student contact hours in each instructional area was divided into the professional travel cost for the instructor in the area.

Inspection of Table 13 shows that the per student contact hour cost per year for professional travel was .8 cent in the machine shop and .7 cent in the sheet metal, foundry, and welding area.

For the fiscal year 1974-75, direct telephone toll charges and postage for the division as obtained from the office of the Comptroller at Norfolk State College was 304.26 dollars. By multiplying this figure by the 7.3-percent prorated enrollment rate, the cost for the metals cluster program was determined to be twenty-two dollars and twenty-one cents.

The total 1975-76 proposed metals cluster telephone service charge, as obtained from the service consultant of the Chesapeake and Potomac Telephone Company of Virginia, was 165.6 dollars per year. By combining this figure with the prorated cost for toll charges and

Table 13

Cost per Student Contact Hour for
Professional Travel by
Instructional Area

Instructional area	Number of student contact hours per year	Profes- sional travel (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	175.00	0.008
Sheet metal, foundry, and welding	24,192	175.00	0.007
Total	46,512	350.00	0.007

postage, the total cost for telephone service and postage was 187.81 dollars.

To ascertain the cost per student contact hour per year for prorated telephone toll charges, local telephone service charges, and postage, by instructional area, the total number of student contact hours in the metals cluster program was divided into the contact hours in the instructional areas. The derived percentages were then multiplied by the total cost for the metals cluster program to arrive at the cost for each instructional area. Similarly, the number of student contact hours in each instructional area was

divided into the corresponding cost for the area. As indicated in Table 14, the per student contact hour cost per year was .4 cent for prorated telephone toll charges, local telephone service charges, and postage in each instructional area.

Table 14

Cost per Student Contact Hour for Toll
Charges, Postage, and Direct
Telephone Service Charges
by Instructional Area

Instructional area	Number of student contact hours per year	Toll charges, postage, and direct telephone service charges (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	90.15	0.004
Sheet metal, foundry, and welding	24,192	97.66	0.004
Total	46,512	187.81	0.004

An inquiry to the office of Buildings and Grounds at Norfolk State College, revealed that electricity charges by building could not be provided. Therefore, it was decided to estimate the electricity cost for the metal-cluster program by first converting machine horsepower (.746 kilowatts = 1 horsepower) and lamp watts to kilowatts

and kilowatt-hours, respectively. The kilowatt-hours previously identified, were multiplied by the utility rate for electrical energy service to the college in order to estimate the cost of electricity consumed, in the use of the facilities.

Table 15 reveals the estimated electricity cost for utilization of metals cluster machines and light. It is significant to note that the utilization estimate, by machine type, reflects an estimated percentage of machine usage (operational) based upon the estimated hours of operation per year. By dividing the total cost of electricity in Table 15 by the total number of student contact hours, the per student contact hour cost per year for electricity was computed to be two cents.

Of the total electricity cost for use of the metals cluster program machines, 217.22 dollars was assigned to the machine shop area, and 532.9 dollars was assigned to the sheet metal, foundry, and welding area. Since the space assigned for use in the machine shop and sheet metal, foundry, and welding area was 58 percent and 42 percent, respectively, the prorated electricity cost for light usage, by instructional area, was determined to be 100.85 dollars and seventy-three dollars and three cents, respectively. The combined electricity cost was found to be 313.07 dollar, for the machine shop and 605.93 dollars for the sheet metal, foundry, and welding area. By dividing the total number of student contact hours in each instructional area into the combined electricity cost for the area, the per student contact hour cost by instructional area, was

Table 15

Electricity Cost for the Metals Cluster Program

Machine and lamp type	Quan- tity	Horse- power	Kilowatts	Hours of program operation per year (N = 1,080)		Kilowatt- hours (service rate 0.0175)	Cost per year of kilowatt- hours used (\$)
				Use per year Hours	(%)		
Machine shop							
Milling machine, horizontal	1	5.0	3.73	216.0	20.0	805.68	14.10
Lathe, engine, 15" x 50"							
centers	2	15.0	11.19	324.0	30.0	3,625.56	63.45
Lathe, engine, 13" x 24"							
centers	5	25.0	18.65	324.0	30.0	6,042.60	105.74
Milling machine, vertical	1	2.0	1.492	216.0	20.0	322.27	5.64
Grinder, surface	1	1.0	0.746	108.0	10.0	80.57	1.41
Grinder, universal-cylindrical	1	5.0	3.73	108.0	10.0	402.84	7.05
Drill press	1	1.5	1.119	54.0	5.0	60.43	1.06

Machine and lamp type	Quantity	Horse-power	Kilowatts	Hours of program operation per year. (N = 1,080)		Kilowatt-hours (service rate 0.0175)	Cost per year of kilowatt- hours used (\$)
				Use per year Hours	(%)		
Shaper, horizontal	1	3.0	2.238	216.0	20.0	483.41	8.46
Bandsaw machine, vertical	1	3.0	2.238	54.0	5.0	120.85	2.11
Bandsaw machine, horizontal	1	0.75	0.5595	54.0	5.0	30.21	0.53
Grinder, tool and cutter	1	0.50	0.373	32.0	3.0	11.94	0.21
Grinder, pedestal, 7"	1	0.50	0.373	75.6	7.0	28.20	0.49
Grinder, pedestal, 12"							
Service life expended)	1	2.0	1.492	75.6	7.0	112.79	1.97
Subtotal						12,127.35	212.22
Sheet metal, foundry and welding							
Heat treatment furnace	1	--	13.0	86.4	8.0	1,123.20	19.66
Foundry furnace	1	0.75	0.5595	21.6	2.0	12.08	0.21
Batch muller	1	3.0	2.238	21.6	2.0	48.34	0.84
Dry rod oven	1	--	1.0	108.0	10.0	108.00	1.89

Machine and lamp type	Quantity	Horsepower	Kilowatts	Hours of program operation per year (N = 1,080)		Kilowatt-hours (service rate 0.0175)	Cost per year of kilowatt-hours used (\$)
				Use per-year Hours	(%)		
Spot welder, 20 kva Transformer-rectifier AC/DC welding machine	1	--	20.0	54.0	5.0	1,080.00	18.90
Transformer-rectifier AC/DC welding machine	1	--	21.8	432.0	40.0	9,417.60	164.81
Transformer-rectifier AC/DC welding machine	2	--	30.2	432.0	40.0	13,046.40	228.31
Mig-rectifier DC welding machine	1	--	13.0	432.0	40.0	5,616.00	98.28
Subtotal						30,451.62	532.90
Metals cluster program Fluorescent	104 ^a	--	9.20	1,080.0	100.0	9,936.00	173.88
Total						52,514.97	919.00

^aIncludes eighty, eight-foot lamps at 100 watts each and twenty-four, four-foot lamps at 50 watts each.

computed to be 1.4 cents and 2.5 cents, respectively, as is shown in Table 16.

Table 16
Cost per Student Contact Hour for
Electricity by Instructional
Area

Instructional area	Number of student contact hours per year	Electricity cost (\$)	Per student contact hour cost per year (\$)
Machinist shop	27,320	313.07	0.014
Sheet metal, foundry, and welding	24,192	605.93	0.025
Total	46,512	919.00	0.020

The 1975-76 cost of heat (oil) for the building (5,374.5 dollars) was obtained from the office of Buildings and Grounds at North Dakota State College. By multiplying this figure by 6.5 percent, the net assignable metals cluster space, the cost of heat for the metals cluster program was calculated to be 349.34 dollars. Dividing this figure by the total number of student contact hours fixed the cost per student contact hour per year for heat at .7 cent.

To compute the cost for heat, by instructional area, the

percentage of prorated space for the machine shop area (58 percent) and the sheet metal, foundry, and welding area (42 percent) was multiplied by the heating cost for the net assignable metals cluster space. The prorated cost was 202.62 dollars for the machine shop area and 146.72 dollars for the sheet metal, foundry, and welding area. The cost per student contact hour per year, by instructional area, was ascertained by dividing the number of student contact hours in each instructional area into the corresponding prorated cost for heat for the area. Table 17 shows that the per student contact hour cost for heat was .9 cent in the machine shop and .6 cent in the sheet metal, foundry, and welding area.

Table 17
Cost per Student Contact Hour for Heat by
Instructional Area

Instructional area	Number of student contact hours per year	Heat cost (\$)	Per student contact hour cost per year (\$)
Machine shop	22,320	202.62	0.009
Sheet metal, foundry, and welding	24,192	146.72	0.006
Total	46,512	349.34	0.007

Table 18 shows the distribution of per student contact hour costs per year for the various expenditure items for the metals cluster program. Of the total per student contact hour cost for the program, approximately 75 percent was attributable to the costs of instructional service and equipment.

Table 19 shows expenditure items, together with the costs and per student contact hour costs per year by instructional area. Inspection of the data shows that total costs were greatest in the machine shop, 31,767.97 dollars, and least in sheet metal, foundry, and welding area, 20,566.7 dollars. The per student contact hour cost per year was, therefore, highest in the machine shop, 1,423 dollars, and lowest in sheet metal, foundry, and welding area, eighty-five cents. Of the total per student contact hour cost for the machine shop approximately 78 percent was attributable to the costs of instructional service and equipment. Of the total per student contact hour cost for sheet metal, foundry, and welding, approximately 72 percent was attributable to the costs of instructional service and equipment.

As shown in Table 18, the total cost for all expenditure items, including the estimated variable of maintenance and operation costs for electricity and heat, was determined to be 52,334.67 dollars. Since the 1975-76 equipment funds were approximately half of the amount needed for acquisition of all equipment items, it was decided to make a one-year inflation adjustment in the total program cost. By temporarily removing the net assignable space depreciation cost (3,810.9 dollars), and approximately 6,512.11 dollars, or 50 percent, of the total equipment depreciation cost, the total cost was adjusted to 42,011.47 dollars. By multiplying this

Table 18

Distribution of per Student Contact Hour
Costs for Objects of Expenditure for
the Metals Cluster Program
(N = 46,512 contact hours)

Expenditure item	Total cost per year (\$)	Cost per student contact hour per year	
		(\$)	(%)
Net assignable space depreciation	3,810.90	0.082	7.29
Equipment depreciation	13,024.62	0.280	24.89
Equipment repairs	686.02	0.015	1.33
Net assignable space insurance	84.82	0.002	0.18
Consumable supplies	3,297.64	0.071	6.31
Instruction	26,000.00	0.559	49.69
Instructional support	475.20	0.010	0.89
Administration, secretaries, office supplies, rental of xerox machine, office machine repairs, and printing	3,149.32	0.068	6.04
Professional travel	350.00	0.007	0.62
Telephone and postage	187.81	0.004	0.36
Electricity	919.00	0.020	1.78
Heat (oil)	349.34	0.007	0.62
Total	52,334.67	1.125	100.00

Table 19

Distribution of per Student Contact Hour Costs for
Objects of Expenditure by Instructional Area

Expenditure item	Machine shop area (N = 22,320 contact hours)			Sheet metal, foundry and welding area (N = 24,192 contact hours)		
	Total cost per year (\$)	Cost per stu- dent contact hour per year (\$)	(%)	Total cost per year (\$)	Cost per stu- dent contact hour per year (\$)	(%)
Net assignable space depreciation	2,201.48	0.099	6.96	1,609.42	0.067	7.88
Equipment depreciation	11,511.35	0.516	36.26	1,513.27	0.062	7.29
Equipment repairs	623.68	0.028	1.97	62.34	0.003	0.35
Net assignable space insurance	49.20	0.002	0.14	35.62	0.001	0.12
Consumable supplies	1,852.15	0.082	5.76	1,445.49	0.060	7.06
Instruction	13,000.00	0.582	40.90	13,000.00	0.537	63.18
Instructional support	237.60	0.011	0.77	237.60	0.010	1.18
Administration, secretaries, office supplies, rental of xerox machine, office machine repairs, and printing	1,511.67	0.068	4.78	1,637.65	0.068	8.00
Professional travel	175.00	0.008	0.56	175.00	0.007	0.82

Table 19 (continued)

Expenditure item	Machine shop area (N = 22,320 contact hours)			Sheet metal, foundry and welding area (N = 24,192 contact hours)		
	Total cost per year (\$)	Cost per stu- dent contact hour per year (\$)	Cost per stu- dent contact hour per year (%)	Total cost per year (\$)	Cost per stu- dent contact hour per year (\$)	Cost per stu- dent contact hour per year (%)
Telephone and postage	90.15	0.004	0.28	97.66	0.004	0.47
Electricity	313.07	0.014	0.98	605.93	0.025	2.94
Heat (oil)	202.62	0.009	0.63	146.72	0.006	0.71
Total	31,767.97	1.423	99.99	20,566.70	0.850	100.00

figure by the assumed 10 percent inflation rate, the additional cost for the projected year (1976-77) was determined to be 4,201.15 dollars. By combining the figure of 52,334.67 dollars for the base year (1975-76) with the inflation figure of 4,201.15 dollars for the projected year (1976-77), the estimated total cost for the projected year was determined to be 56,535.82 dollars.

Figure 1 presents data pertaining to the average per student contact hour cost per year at increasing levels of enrollment. The per student contact hour cost per year was computed by dividing the estimated total program cost (56,535.82 dollars) for the projected year (1976-77) by each level of enrollment. Inspection of the data in Figure 1 reveals that, as the number of student contact hours increased, the average per student contact hour cost decreased. It is significant to note that by adding one additional student (290 contact hours) to the planned optimum enrollment level, the differential cost was determined to be approximately one cent per student contact hour. It is also significant to note that student-contact-hour production is basically a function of physical facility and equipment. Further, since the total program cost (56,535.82 dollars) is not a constant, the cost will go down as long as the operation is below capacity. On the other hand, as long as more students can be serviced by lengthening the school day, additional fixed and variable costs will be incurred. In addition, it may be noted that oversaturation of the instructional space will influence the need for additional building space.

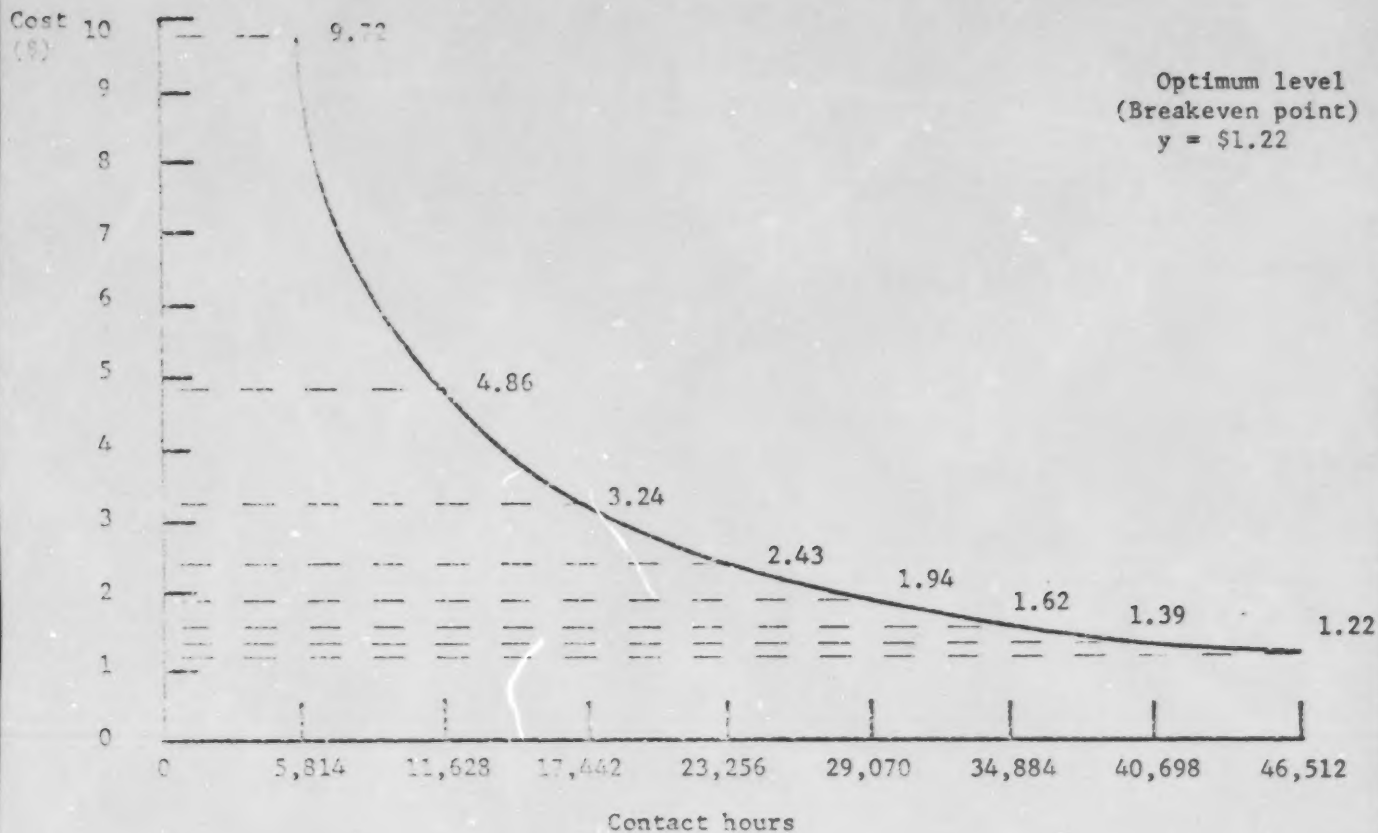


Figure 1

Average per Student Contact Hour Cost per Year at
Increasing Levels of Enrollment

Comparative information concerning the costs associated with additional enrollment is shown in Table 20. To compute the cost per student per year, by program track, the total class hours were multiplied by the cost per class hour to obtain the cost per year. The cost per year was then divided by the respective section enrollment. Examination of the table shows that the costs per student per year ranged from 101.23 dollars in the industrial arts general metal track to 423.9 dollars in the two-year terminal machine shop track.

Table 20

Comparative Costs for Additional Class Sections in
the Metals Cluster Program

Program track	Total class hours required	Section enroll- ment	Cost		
			Per class hour ^a (\$)	Per year (\$)	Per student per year (\$)
Two-year terminal machine shop	10,800	20	0.785	8,478.00	423.90
Two-year terminal welding	17,280	32	0.703	12,147.84	397.62
Drafting and design machine shop	8,640	40	0.785	6,782.40	169.56
Industrial arts machine shop	2,880	20	0.785	2,260.80	113.04
Industrial arts general metals	6,912	48	0.703	4,859.14	101.23

^aIncludes the following expenditures from Table 19: equipment repairs; consumable supplies; instruction; instructional support; administration, secretaries, office supplies, rental of xerox machine, office machine repairs, and printing; and electricity.

Chapter 5

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

SUMMARY

Facility and program planning involve many factors which are not readily evident in the initial planning stages of an educational school plant. Oftentimes, decision-making is obscured by inadequate information for choosing among alternatives.

Consequently, continuous planning must focus on need studies, employment opportunities, space, equipment, students, and studies of unit costs. These factors provide the basis for efficient allocation of resources.

Adequate disclosure of cost accounting and budgeting information is vital, in that these data are tools for an effective management system. A general lack of cost data makes it difficult for administrative personnel to establish financial controls and apply budget standards.

The purpose of the study was to develop a model which could be used to assist school administrators to estimate the costs associated with the delivery of a metals cluster program at Norfolk State College. Further, the study sought to construct the model in such a manner that costs could be explained as a function of enrollment levels.

This study differed from other related studies in that it included an expanded list of input costs.

Initially, data pertinent to the study of this problem were obtained through a review of available literature; computer searches of ERIC Clearinghouse in Career Education; and consultations with knowledgeable persons in the fields of accounting and administration. Specific basic cost data were secured by means of direct inquiry addressed to qualified sources; records; building plans and specifications; equipment suppliers' catalogs, specifications, and quotations; and the utilization of engineering formulas and constants.

Upon collecting the basic cost data, the methodology of this study focused upon separating the expenditures into direct and indirect expenditure categories. Having completed this task, an accounting framework and methods of allocation applicable to the various overhead costs were identified and adopted for use. The cost center concept was then applied in order to collect expenditures relating to each function. The expenditures which were readily identified with the cost centers were assigned on a direct basis to these centers or functions. The expenditures which were not identified with the cost centers, or expenditures classified as indirect expenditures, were prorated to the individual cost centers by using a "step-down" allocation procedure. That is, expenditures at one level were prorated to lower levels in proportion to the burden created by the individual cost centers. The variables identified to allocate the indirect expenditures to the cost centers included net assignable space, student enrollment, and student

contact hours.

Unit costs were computed by dividing each category of expenditure for the metals cluster program and corresponding instructional areas by the respective total number of student contact hours.

After the unit costs were computed for the metals cluster program and corresponding instructional areas, the estimated total program expenditure was adjusted for inflation for a one-year projection. The full unit cost was then computed at increasing levels of enrollment.

SUMMARY OF MAJOR FINDINGS

The major findings may be summarized as follows:

1. Cost accounting concepts and procedures can be used to compute per student contact hour costs for a program and individual instructional areas.
2. Instructional salaries comprised the largest single element in the per student contact hour costs for the program and corresponding instructional areas.
3. Approximately 75 percent of the total per contact hour cost for the metals cluster program was attributable to the high costs of instructional service and equipment.
4. The average per student contact hour cost per year for the machine shop area was found to be higher than that for the sheet metal, foundry, and welding areas.
5. It was found that the cost per student contact hour

declined as the enrollment increased to optimum size.

6. Given available space, the cost differential, the reduced cost per student contact hour per year, resulting from adding an additional student was found to be approximately one cent per student contact hour.

7. It was observed that the kinds of costs expected to be incurred to service additional enrollment by lengthening the school day were: equipment repairs, consumable supplies, instruction, instructional support, administration et cetera, and electricity.

CONCLUSIONS

On the basis of the evidence and limitations of this study, it appears reasonable to conclude:

1. Careful and systematic application of cost accounting concepts and procedures will result in per student costs for a program and individual instructional areas.
2. Depreciation of net assignable space and equipment requires useful life estimates.
3. Instructional salaries will comprise the largest single element in the per student contact hour costs for the metals cluster program and corresponding instructional areas.
4. Approximately 75 percent of the total per student contact hour cost for the program will be attributable to the high cost of instructional service and equipment.
5. The per student contact hour cost will be higher for the

machine shop area than for the sheet metal, foundry, and welding area.

6. Economies of scale will result by operating at the planned optimum enrollment level. That is, as the number of student contact hours increases, the cost per student contact hour will decrease.

7. It may be expected that added costs will be incurred to service additional enrollment by lengthening the school day.

8. Since the evidence revealed that the model could be used to estimate per student contact hour costs, the model appears to be acceptable for estimating costs associated with other programs.

IMPLICATIONS

Through the conduct of the study, the following implications emerge:

1. Since the need for cost accounting information is evident, unit cost and budgeting research should have significant financial value.

2. It seems reasonable to assume that this study should be useful as a format for estimating costs in other areas of the division and the college.

3. Per student cost data should enable the administration of the college to compare costs on a year to year basis.

4. Although this study has provided a framework for estimating costs using cost accounting concepts and methodology, it would seem to be only the initial step toward the program budgeting process.

5. The model could be improved by including per student costs.

by track and emphasis level.

6. The application of the computer to unit cost and budgeting research should reduce the time for making analyses.

RECOMMENDATIONS

In view of the limitations of the study, the following recommendations seem warranted:

1. Efforts should be made to determine appropriate depreciation factors with the assistance of a panel of experts.
2. Experimentation to determine materials actually used in programs of various types would be worthwhile.
3. Administrative time analyses should be made to more effectively allocate administrative costs.
4. Unit cost and budgeting research should be conducted in other areas of the division and the college.
5. Provisions should be made for obtaining financial expenditure data for unit cost and budgeting research.
6. This study should be replicated in order to estimate the per student contact hour cost by track and emphasis level.
7. The division should formulate a mission statement that specifies goals and objectives for each of the various programs in the division.
8. Standardized methods of cost accounting should be developed and implemented by the college to aid in recording and analyzing costs of programs in operation and those that are planned.

9. The application of the computer to unit cost and budgeting studies should be considered.

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APPENDIXES

APPENDIX A

EMPHASES DESIGNATIONS AND OBJECTIVES

Level I Machine Shop Emphasis
for Drafting and Design
Students

The three-semester hour basic machine shop emphasis for drafting and design students will be designed to provide an elementary and practical approach to the study of metals, their structure, markings, classifications, and uses. Interpretations of properties and specifications of steel and selected nonferrous metals will be made by use of manuals, catalogs, and charts. Also, the student will be introduced to the procedures of layout work and the correct use of hand and machine tools. Experiences will be provided in the basic fundamentals of drill press and lathe operations, hand grinding of drill bits and lathe tools, set-up work, and the design of a functional tool or drill jig.

Objectives. As a result of laboratory sessions, lecture-demonstrations, demonstrations, field trips, individual study, and participation in the basic machine shop activities, each drafting and design student should:

1. Develop technical knowledge of the characteristics and properties of common metals.
2. Acquire technical knowledge and practice in the use of common hand and machine tools.
3. Develop a degree of competence in performing bench work, basic layout, bench and pedestal grinding, basic set-up, and

operations on the drill press and engine lathe.

4. Acquire experience in designing a functional tool or drill jig.

Level II Machine Shop Emphasis
for Drafting and Design
Students

The three-semester hour advanced machine shop emphasis will provide experiences in the use, set-up, and care of the grinders, milling machines, and shaper. Experiences will be given in the use of precision tools and measuring instruments such as the vernier height gauge, protractor, and comparator. Also, time will be planned to provide experiences appropriate to the design of a functional drill jig or fixture.

In view of the limited time allotment and objective of this emphasis, laboratory sessions, demonstrations, and exercise work shall replace the usual project method of instruction. This emphasis is intended to enhance the student's knowledge of the technology of machining practices and the capabilities of machines and tools involved.

Objectives. As a result of laboratory sessions, demonstrations, exercise work, and assignments in the advanced machine shop emphasis, each drafting and design student should:

1. Acquire basic operational and set-up experiences in the use of the vertical and horizontal milling machine, precision grinder, etc., and shaper.

2. Acquire knowledge and experience for planning and designing special tools such as jig and milling fixtures.

3. Become knowledgeable of the nature of machine tools, their uses, capabilities, and limitations to design considerations.

Level I Emphasis (Basic
General Metals) for
Industrial Arts
Students

The Level I, two semester hour introductory emphasis, will consist of exploratory activities in sheet metal, foundry, and welding. Equal time will be spent in the various areas to provide technical knowledge and basic manipulative skills in selected industrial processes of industry.

Objectives. As a result of laboratory sessions, lecture-discussions, demonstrations, field trips, individual study, and participation in the Level I exploratory activities, each industrial arts student should:

1. Acquire an interest in important industrial processes of the metals field.
2. Develop technical knowledge of characteristics and properties of common metals.
3. Demonstrate fundamental knowledge and technical skills in sheet metal layout and fabrication, foundry, and oxyacetylene and arc welding procedures.

Level II Emphasis (Basic
Machine Shop) for
Industrial Arts
Students

The two-semester hour basic machine shop emphasis will be designed to extend the student's knowledge of measurement, hand tools and bench work, and layout involving the use of the vernier height gauge, the surface gauge, and the precision "V" block. Experiences will be provided in the basic fundamentals of drill press and lathe operations, hand grinding of drill bits and lathe tools, and set-up work.

Objectives. As a result of laboratory sessions, lecture-discussions, demonstrations, field trips, individual study, and participation in the basic machine shop activities, each industrial arts student should:

1. Acquire technical knowledge and practice in the use of common hand and machine tools.
2. Demonstrate a degree of competence in performing bench work, basic layout, bench and pedestal grinding, basic set-ups, and operations on the drill press and engine lathe.

Level III Emphasis (Advanced
Machine Shop) for
Industrial Arts
Students

The two-credit semester hour advanced machine shop emphasis will provide additional experiences beyond those gained in the

Level II emphasis. Consideration will be given to individual and group study and practice of milling machine work, shaper work, heat treatment processes, materials testing processes, and precision grinding processes. Information and experiences appropriate to the use of the precision vernier height gauge, protractor, and comparator will be included in the emphasis.

Objectives. As a result of laboratory sessions, demonstrations, individual study, and participation in the advanced machine shop activities, each industrial arts student should:

1. Acquire operational and set-up experience in the use of the vertical and horizontal milling machine, shaper and precision grinders.
2. Acquire heat treatment and metallurgical concepts and practice by hardening, hardness testing, and tensile testing prepared metal specimens.

Level I Emphasis (Basic
Welding) for Two-
Year Technical
Students

The basic welding emphasis will be vocationally oriented and will include fifteen contact hours per week. The emphasis will be designed to provide an elementary and practical approach to the study of metals, their structure, markings, classifications, and uses. Interpretation of properties and specifications of steel and selected nonferrous metals will be made by use of manuals, catalogs, and

charts. Additional study will focus on an introduction to the history of oxyacetylene and arc welding, the principles of welding and cutting, nomenclature of equipment, and assembly of unit. The operation of the AC (alternating current) transformer and the AC and DC (direct current) rectifier arc welding units will be stressed. Welding procedures such as practice of puddling and carrying the puddle; running beads; butt welding in the flat, vertical, and overhead positions; and cutting straight lines with the torch will be the practical emphasis.

Objectives. As a result of laboratory sessions, demonstrations, field trips, individual study, and participation in the basic welding activities, each two-year student should:

1. Develop technical knowledge of the characteristics and properties of common metals.
2. Become acquainted with equipment used in oxyacetylene welding and cutting and arc welding.
3. Acquire technical information concerning heats, rods, and electrodes, polarities, and welding preparation methods and requirements.
4. Acquire the basic principles and procedures of running beads and butt welds in the flat, vertical, and overhead positions.

Level II Emphasis (Advanced
Welding) for Two-Year
Terminal Students

The advanced welding emphasis will be vocationally oriented and will include fifteen contact hours per week. The emphasis will

involve practical operations in the use of inert gas shield arc welding. A study will be made of the equipment operation and safety practices, and welding practice will be provided in the various positions. A thorough study will be made of such topics as principles of operation, shielding gases, filler rods, process variations, and applications. Students will be provided the opportunity of testing the quality of welded specimens by using the liquid penetrant, guided bend, and tensile strength tests.

Objectives. As a result of laboratory sessions, demonstrations, individual study, and participation in the advanced welding activities, each two-year student should:

1. Become acquainted with equipment and acquire knowledge of safety precautions necessary in gas-shielded arc welding.
2. Become knowledgeable of the best shielding gas or gases for a specific purpose.
3. Acquire the basic principles of running beads and fillet welds in all positions by using the metal-inert-gas process.
4. Acquire a degree of competence in testing and inspecting welds.

Level III Emphasis (Basic
Machine Shop) for Two-
Year Terminal
Students

The basic machine shop emphasis will be vocationally oriented and will include fifteen contact hours per week. The emphasis will be

designed to acquaint the student with safety procedures, basic hand and precision measuring instruments, elementary layout procedures, and processes of the drill press, engine lathe, hand grinding of drill bits and lathe tools, and fundamental milling machine operations.

Objectives. As a result of laboratory sessions, demonstrations, field trips, individual study, and participation in the basic machine shop activities, each two-year student should:

1. Acquire a degree of competence in the use of hand and machine tools.
2. Develop self-reliance and confidence in his own abilities.
3. Acquire related technical information and skills to perform bench work, basic layout, bench and pedestal grinding, basic operations on the drill press, engine lathe, and milling machine.

Level IV Emphasis (Advanced
Machine Shop) for Two-
Year Terminal
Students

The advanced machine shop emphasis will be vocationally oriented and will include fifteen contact hours per week. Study will be provided in the use, set up and care of the milling machines, shaper, surface grinder, cylindrical grinder, and the tool and cutter grinder. Considerable time and attention will be given to indexing and the processes of calculating and cutting of spur and helical gears. Information appropriate to the use of the vernier height gauge, protractor, and comparator will also be provided as part of the

emphasis.

Objectives. As a result of laboratory sessions, demonstrations, individual study, and participation in the advanced machine shop activities, each two-year student should:

1. Acquire a level of competence in performing set-ups and operations on the vertical and horizontal milling machine, shaper, and precision grinders.
2. Become knowledgeable of the capabilities and limitations of machine tools.

APPENDIX B

STUDENT CONTACT HOURS PER YEAR BY EMPHASIS
LEVEL FOR THE METALS CLUSTER PROGRAM

Table 21

Student Contact Hours per Year by Emphasis
Level for the Metals Cluster Program

Emphasis track	Track serviced	Annual student contact hours	
		Num-ber	Per-cent
Machining shop			
I	Drafting and design	4,320	9.3
II	Drafting and design	4,320	9.3
II	Industrial arts	1,440	3.1
III	Industrial arts	1,440	3.1
III	Two-year terminal	5,400	11.6
IV	Two-year terminal	5,400	11.6
General metals			
I	Industrial arts	6,912	14.8
Welding			
I	Two year terminal	8,640	18.6
II	Two-year terminal	8,640	18.6
Total		46,512	100.0

APPENDIX C

NET ASSIGNABLE SPACE ASSIGNED FOR USE IN
THE METALS CLUSTER PROGRAM

Table 22

Net Assignable Space Assigned for Use in
the Metals Cluster Program

Specific locations	Net assignable space	
	Area (square feet)	Percent of area (%)
Machine shop		
Laboratory area	2,217	43.80
Office area (50 percent of metals cluster space)	51	1.00
Tool and supply room area	148	2.92
Lecture-Discussion room area (50 percent of metals cluster space)	260	5.13
Student project storage area (50 percent of metals cluster space)	250	4.93
Sheet metal, foundry and welding		
Laboratory area	1,275	25.16
Office area (50 percent of metals cluster space)	51	1.00
Tool and supply room area	304	6.00
Lecture-discussion room area (50 percent of metals cluster space)	260	5.13
Student project storage area (50 percent of metals cluster space)	250	4.93
Total	5,066	100.00